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A Sketch of Mr. Davy's Recent Discoveries of the Chemical Agencies of Electricity, and of the Decomposition and Composition of the Fixed Alkalies, of Ammonia, the Alkaline Earths, &c.

THE preceding historical sketch* of the discoveries in galvanism shows us, that in the first chemical experiments, made with the column of Volta, the appearance of acid and alkaline matter was observed at the opposite electrified metallic surfaces, in water acted on by a current of electricity. These were supposed by Mr. Cruickshank to be the nitrous acid and ammonia, and by M. Desormes, muriatic acid and ammonia; whilst Brugnatelli imagined the formation of a new and peculiar substance, the electric acid. Mr. Davy, as early

* This refers to another article in the same publication.

as 1800, found that nitro-muriatic acid was produced in a tube containing the positive or transmitting wire, and a solution of soda in the opposite tube; and also ascertained that their appearance proceeded from animal or vegetable matters which were employed to connect the tubes. The traces of fixed alkali found by Mr. Sylvester, as mentioned in the preceding sketch, Mr. Davy suspected to have been derived from some of the materials employed in the manufacture of tobacco pipes, the clay used for which was employed by Mr. Sylvester in his experiment.

By a series of excellently devised experiments, Mr. Davy ascertained that distilled water in agate cups, being connected by amianthus, and exposed to a current of electricity, acid matter appeared to be separated by the transmitting or positive wire, and alkaline by the opposite wire; and that the acid was derived from some saline matter existing in the agate; whilst the alkali was yielded by the impurities contained in the distilled water, and carried over in vivid ebullition. In further proof of the fixed alkali not being generated but evolved, some fixed alkali appeared, in almost every intance, where water, even slowly distilled, in vessels of different substances, was the subject of experiment. When tubes of wax were used, a mixture of soda and potash, and a mixture of sulphuric, muriatic, and nitric acids were obtained; and with resin, the alkaline matter seemed to be principally potash. From Carrara marble, the water became impregnated with fixed alkali and lime; and from argillaceous schist, serpentine, grauwacké, and glass, soda was obtained. Having in every experiment with purified water found, that the properties of nitrous acid were produced; that the longer the operation, the greater the quantity that was obtained; that volatile alkali was also produced, but in very minute portions; and that the limit to its quantity

was soon determined, he thought it was natural to account for these results from the combination of nascent oxygen and hydrogen respectively, with the nitrogen of the common air, dissolved in the water; and thought it also evident, that water, chemically pure, is decomposed by electricity into gaseous matter alone, into oxygen and hydrogen.

The acid matter collecting on the positive, and the alkaline on the negative side, in all changes in which acid and alkaline matter were present, manifesting a principle of action apparently related to one of the first phænomena observed in the voltaic pile—the decomposition of the muriate of soda attached to the pasteboard, and to many other instances of separation since observed, Mr. Davy instituted a series of experiments with respect to this subject.

Two cups of compact sulphate of lime, containing about 14 grains of pure water each, were connected by fibrous sulphate of lime moistened with pure water, and placed in the circuit of electricity of the voltaic battery; after an hour, a pure and saturated solution of lime was found in the cup containing the negative wire; and a moderately strong solution of sulphuric acid, in the cup containing the positive wire. Similar satisfactory experiments were made with sulphate of strontites, fluate of lime, and sulphate of barytes. To prove the fact that even very minute portions of acid and alkaline matter might be disengaged by this agency from solid combinations, principally consisting of the pure earths, fine grained basalt, which, in 100 parts, contained only $3\frac{1}{2}$ parts of soda, and nearly $\frac{1}{2}$ a part of muriatic acid, with 15 parts of lime, was made the subject of experiment; and yielded, on the positive side, a fluid smelling strongly of oxymuriatic acid; and, on the other, a substance which seemed to be a mixture of lime and soda. Compact

zeolyte yielded soda and lime; lepidolite, potash; and vitreous lava, an alkaline matter which seemed to be a mixture of soda, potash, and lime. With a view of developing a quantity of alkaline matter capable of being weighed, glass was subjected to the electric influence, when soda mixed with a white powder insoluble in acids, the whole weighing $\frac{36}{128}$ of a grain, was obtained, and a nearly corresponding loss of weight was discovered in the glass. Similar results occurred, with greater rapidity of decomposition, and greater distinctness in the phænomena, when compounds soluble in water were acted upon: lixivium of potash, and a solution of sulphuric acid, being soon extricated from a solution of sulphate of potash. The phænomena were analogous when sulphate of soda, nitrate of potash, nitrate of barytes, sulphate of ammonia, phosphate of soda, succinate, oxalate, and benzoate of ammonia, and alum were used. The acids in a certain time collected in the tube which contained the positive wire, and the alkalies and earths in that containing the negative wire. Muriatic salts uniformly gave oxymuriatic acid; compatible mixtures of neutrosaline solutions containing the common mineral acids, yielded their different bases and different acids separated together in a mixed state, without any respect to the orders of affinity; and, when metallic solutions were employed, metallic crystals with oxide were found on the negative, and a great excess of acid on the positive side. Although saturated solutions suffered more rapid decomposition than weak ones, yet the smallest proportion of neutrosaline matter seemed to be acted on with energy; and, in every case where the results were distinct, the separation of the constituent parts was complete from the last portions of the compound.

The experiments of Messrs. Gautherot, Hisinger, and Berzelius, having rendered it probable, that the saline elements

evolved in decompositions by electricity were capable of being transferred from one electrified surface to another, according to their usual order of arrangement, Mr. Davy formed a suit of experiments with the hope of demonstrating this fact. He connected a cup of sulphate of lime with a cup of agate by asbestus, and filling them with pure water, made the platina wire in the cup of sulphate of lime transmit the electricity, which was received by a wire in the agate cup. A strong solution of lime was thus obtained in the agate cup, and sulphuric acid in the other cup. Reversing the order, the sulphuric acid was found in the agate, and the lime in the other cup. Many other trials were made with other saline substances, with analogous results. When compounds of the strong mineral acids with alkaline, or alkaline earthy bases, were introduced into one tube of glass, distilled water connected by amianthus being in the other tube, and both connected by wires of platina in the voltaic arrangement, the base always passed into the water, when it was negative, and the acid, when it was positive. The metals, and the metallic oxides, like the alkalies, passed towards the negative surface and collected round it. Nitrate of silver being on the positive side, and distilled water on the negative; silver appeared on the transmitting amianthus, so as to cover it with a thin metallic film. The time required for these transmissions seemed to be, in some proportion, as the length of the intermediate volume of water. To ascertain whether the contact of the saline solution with a metallic surface was necessary for the decomposition and transfer, Mr. Davy so connected, by amianthus, the purified water in two glass tubes, with a vessel containing muriate of potash, that the level of the water was higher than that of the solution, and the saline matter was at least two-thirds of an inch distant from each of the wires, yet the alkali soon appeared in one tube, and the acid in the other. Endeavouring to mark the progress of the transfer, and the

course of the acid or alkaline matter in these decompositions, by the means of litmus and turmeric, some very singular and unexpected circumstances were discovered. Distilled water, and solution of sulphate of potash, were each connected, by amianthus, with water tinged by litmus, the solution being negatively electrified; and to detect the acid in its passage, slips of turmeric paper were placed above and below the amianthus, directly in the circuit. The first manifestation of the acid was observed, where it was least expected, immediately above the opposite, the positive, surface, where a redness took place, which slowly diffused itself from the positive side to the middle of the vessel; but no redness appeared above the amianthus, nor about it on the negative side; and, though it had been constantly transmitting sulphuric acid, it remained unaffected to the last. The order of the experiment being then changed, the effect was precisely analogous, turmeric was rendered brown, first near the negative wire, and no change took place in the intermediate vessel near the positive wire. A beautiful experiment, with corresponding results, was made, in a similar way, with muriate of soda, the intermediate fluid being solution of sulphate of silver, with turmeric paper on the positive, and litmus paper on the negative side. As soon as the electric circuit was complete, soda appeared in the negative, and oxymuriatic acid in the positive tube; the alternate products being exhibited in the metallic solution by their peculiar precipitates, whilst neither the turmeric transmitting the alkali, nor the litmus transmitting the acid, had their tints in the slightest degree altered.

Acids and alkaline substances having been thus found to be transferred through vegetable colours without affecting them, led to the inquiry whether they would not pass through chemical menstrua having stronger attractions for them; and, for

this purpose, the menstrua of stronger attraction was made the middle link of the conducting chain. Solution of sulphate of potash was placed in contact with the negative point, and pure water in contact with the positive point, a solution of ammonia being made the intermediate link; when the sulphuric acid was found to pass through the ammonia, and manifest itself about the opposite, positive point. Similar results ensued when potash and soda solutions were the intermediate fluids; and the acid was exhibited in a certain period, even when transmitted through the most saturated alkaline lixivium: through which muriatic acid from muriate of soda, and nitric acid from nitrate of potash, were, in the same manner, also transmitted. By an appropriate arrangement, the alkaline matter was also transmitted from neutral salts with base of lime, soda, potash, ammonia, or magnesia, through solutions of sulphuric, muriatic, or nitric acid, to the negative surface. Strontites and barytes passed readily through muriatic and nitric acids; and, *vice versa*, these acids passed with facility through aqueous solutions of barytes and strontites: but when sulphuric acid was employed, the results were very different. With sulphate of potash in the negative, distilled water in the positive, and saturated solution of barytes in the middle part of the circuit, only a minute portion of sulphuric acid appeared even after four days, but much sulphate of barytes had formed in the intermediate vessel; the solution of barytes having become so weak as barely to tinge litmus, and having acquired a thick film of carbonate of barytes on its surface. With the muriate of barytes made positive, the acid intermediate, and distilled water negative, no barytes appeared in the water in four days, but much oxymuriatic acid was formed in the positive, and much sulphate of barytes deposited in the sulphuric acid. Such of the metallic oxides as were tried passed through acid solutions from the positive to the negative side, but the effect

was much longer in taking place than in the transition of alkaline matter. Green oxide of iron was thus separated from a solution of green sulphate of iron, in about ten hours, having passed through a solution of muriatic acid. These experiments were repeated with numerous variations. Several experiments of transition were also made upon vegetable and animal substances with perfect success; the saline matter exposed in contact with the metal, and that existing in the vegetable or animal substances, both undergoing decomposition and transfer. The leaf-stalk of the polyanthus thus yielded potash and lime; and a piece of muscular flesh of beef was found to yield soda, ammonia, and lime. From experiments by the means of common electricity, Mr. Davy also determined that there can be no doubt that, *the principle of action is the same in common and in voltaic electricity.*

A general expression of the facts relating to these changes and transitions by electricity, Mr. Davy thinks, may be made in common philosophical language, by saying that, *hydrogen, the alkaline substances, the metals, and certain metallic oxides, are attracted by negatively electrified metallic surfaces, and repelled by positively electrified metallic surfaces; and, contrariwise, that oxygen and acid substances are attracted by positively electrified metallic surfaces; and that these attractive and repulsive forces are sufficiently energetic to destroy or suspend the usual operation of elective affinity.* Mr. Davy supposes, that the repellent and attractive energies are communicated from one particle to another particle of the same kind, so as to establish a conducting chain in the fluid, and that the locomotion takes place in consequence. In agreement with this beautiful theory, it was found that acid existed in all the alkaline solutions through which the acids had been transmitted, whenever any matter remained at the original source:

in time, the decomposition and transfer would undoubtedly have become complete. In the cases of the separation of the constituents of water, and of solutions of neutral salts forming the whole of the chain, there may, Mr. Davy thinks, be a succession of decompositions and recompositions throughout the fluid. This idea is strengthened by the failure of the attempt to pass barytes through sulphuric acid, and muriatic acid through solution of sulphate of silver; in which, as insoluble compounds are formed, and carried out of the sphere of electrical action, the power of transfer is destroyed. Thus also magnesia, and the metallic oxydes, will pass along moist amianthus, from the positive to the negative surface; but if a vessel of pure water be interposed, they do not reach the negative vessel, but sink to the bottom. In the experiment, in which a small portion of sulphuric acid seemed to pass through weak solutions of strontites and barytes, it is most ingeniously suggested, that it was carried through by a thin stratum of pure water, where the solution had been decomposed at the surface by carbonic acid; since, when the film of carbonate was often removed, and the fluid agitated, no particle of sulphuric acid appeared in the positive part of the chain. It is easy, Mr. Davy says, to explain, from the general phænomena of decomposition and transfer, the mode in which oxygen and hydrogen are separately evolved from water. The oxygen of a portion of water is attracted by the positive surface, at the same time that the other constituent part, the hydrogen, is repelled by it; and the opposite process takes place at the negative surface. In the middle, or neutral point, of the circuit, whether there be a series of decompositions and recompositions, or whether the particles from the extreme points only are active, there must be a new combination of the repelled matter; and the case is analogous to that of two portions of muriate of soda separated by distilled water; muriatic acid is

repelled from the negative side, and soda from the positive side, and muriate of soda is composed in the middle vessel.

Mr. Bennet had shown that many bodies brought into contact, and then separated, exhibited opposite states of electricity. Volta has since distinctly shown it in metallic combinations, and supposed that it also took place with regard to metals and fluids. Mr. Davy discovered, in 1801, that, in electrical combinations by means of alternations of single metallic plates and of different strata of fluids, alkaline solutions always received the electricity from the metal, and the acid always transmitted it to the metal. These principles he thus applies to the explanation of the general phænomena of decomposition and transference above described. *In the simplest case of electrical action, the alkali which receives electricity from the metal would necessarily, on being separated from it, appear positive, whilst the acid, under similar circumstances, would be negative; and these bodies having respectively, with regard to the metals, that which may be called a positive and negative electrical energy, in their repellent and attractive functions, seem to be governed by laws the same as the common laws of electrical attraction and repulsion;*—THE BODY POSSESSING THE POSITIVE ENERGY BEING REPELLED BY POSITIVELY ELECTRIFIED SURFACES, AND ATTRACTED BY NEGATIVELY ELECTRIFIED SURFACES; AND THE BODY POSSESSING THE NEGATIVE ENERGY FOLLOWING THE CONTRARY ORDER. A number of experiments were made with a view of elucidating this idea, and of extending its application, and were found to tend, in all cases, to confirm the analogy. Thus charcoal with water and nitric acid; the same substance, water and soda, being arranged in different electrical combinations, a positive energy was manifested on the side of the alkali, and a negative on that of the acid, when twenty alternations were put

together. Similar phænomena appeared on the employment of a pile of zinc, moistened pasteboard, and quick-lime. The alkaline and acid substances, capable of existing in the dry and solid form, gave by contact exceedingly sensible electricities. Thus oxalic, succinic, benzoic, or boracic acid, perfectly dry, being touched upon an extended surface with a plate of copper insulated by a glass handle, the copper was found positive, the acid negative; and when metallic plates were made to touch dry lime, strontites, or magnesia, the metal became negative; soda affected the metal in the same way; but potash was prevented from yielding a satisfactory result by its powerful attraction for moisture. Sulphuric acid being decomposed by voltaic electricity, the sulphur separated on the negative side; and the phosphorus, from the phosphoric acid, combined in the form of a phosphuret with the negatively electrified metal. That oxygen and hydrogen, agreeable to the general principle, possess, with regard to the metals respectively, the negative and positive energy, was satisfactorily shown by numerous observations on the agency of their compounds.

As the chemical attraction between two bodies seems to be destroyed by giving one of them an electrical state, different from that which it naturally possesses; that is, by bringing it artificially into a state similar to the other; so it may be increased by exalting its natural energy. Although it may be useless, in the present state of our knowledge, to speculate on the remote cause of the electrical energy; or on the reason why different bodies, after being brought into contact, should be differently electrified, its relation to chemical affinity is, however, sufficiently evident. May it not, this justly celebrated philosopher asks, be identical with it, and an essential property of matter? The coated glass-plates of Becearia strongly adhere

to each other, when oppositely charged, and retain their charges on being separated. This fact, Mr. Davy observes, affords a distinct analogy to the subject; *different particles, in combining, must still be supposed to preserve their peculiar states of energy.* This hypothesis, indeed, seems naturally to arise from the facts, and to coincide with the laws of affinity. The general idea affords an easy explanation of the influence of affinity by the masses of the acting substances, as elucidated by the experiments of M. Berthollet. Allowing combination to depend upon the balance of the natural electrical energies of bodies, a MEASURE might even be found of the artificial energies, as to the intensity and quantity, capable of destroying this equilibrium; and such a measure would enable us to make A SCALE OF ELECTRICAL POWERS *corresponding to degrees of affinity.*

As heat and light result from all intense chemical action, so when bodies artificially brought into a high state of opposite electricity are made to restore the equilibrium, heat and light are the common consequences. The effect of heat, in producing combination, is also hereby illustrated, since in a number of cases the electric energies of bodies are exalted by heat, as in glass, tourmalin, and sulphur.

The great tendency of the attraction of the different chemical agents, by the positive and negative surfaces in the voltaic apparatus, seems to be to restore the electrical equilibrium: thus, in a voltaic apparatus with copper, zinc, and solution of muriate of soda, copper being brought into contact with the zinc on both sides, the equilibrium is directly restored, and the circulation of electricity ceases; and oxygen and acids, attracted by the positively electrified zinc, exert similar agencies to the

copper, but, probably, in a slighter degree; and being capable of combination with the metal, they produce a momentary equilibrium only. The electrical energies of the metals with regard to each other, or the substances dissolved in the water, in the voltaic and other analogous instruments, seem to be the causes that disturb the equilibrium, and the chemical changes the causes that tend to restore the equilibrium; the phænomena most probably depending on their joint agency. When a pile of zinc, copper, and solution of muriate of soda, is in its condition of electric tension, the communicating plates of copper and zinc are in opposite electrical states; and water being, as to electricities of such very low intensities, an insulating body, every copper plate produces, by induction, an increase of positive electricity upon the opposite zinc plate, and every zinc plate an increase of negative electricity on the opposite copper plate: the intensity increasing with the number, and the quantity with the extent of the series. When a communication is made between the two extreme points, the opposite electricities tend to annihilate each other; and if the fluid medium could be a substance incapable of decomposition, the equilibrium, there is every reason to believe, would be restored, and the motion of the electricity cease. But solution of muriate of soda being composed of two series of elements possessing opposite electrical energies, the oxygen and acid are attracted by the zinc, and the hydrogen and the alkali by the copper: the balance of power is, however, only momentary, for solution of zinc is formed, and the hydrogen disengaged. The negative energy of the copper, and the positive energy of the zinc, are consequently again exerted, enfeebled only by the opposing energy of the soda in contact with the copper, and the process of electromotion continues, as long as the chemical changes are capable of being carried on.

In conformation of this theory it may be observed, that the voltaic pile, when the connecting fluid is water free from air, or concentrated sulphuric acid, exhibits no permanent electromotive power, little or no chemical action going on. But water containing air, and still more if holding loosely combined oxygen, produces continued electromotion; and diluted acids, from increase of decomposition, are above all other substances powerful. Neutrosaline solutions are found to lose their energy as their acid arranges itself on the sides of the zinc, and their alkali on the copper: their powers becoming much revived by mixing the fluid well together. As when an electrical discharge is produced, by means of small metallic surfaces, of the voltaic battery, sensible heat is the consequence, it occurred to Mr. Davy, that if the decomposition of the chemical agents was essential to the balance of the opposed electricities, the effect, in a saline solution, of this decomposition, and the accompanying transfers, ought to be connected with an increase of temperature. A beautiful experiment confirmed the conjecture, and proved, with the other facts just mentioned, *that the decomposition of the chemical menstrua was essential to the continued electromotion in the pile.* The same principles will apply to all the varieties of the electrical apparatus, whether containing single or double plates, proving that, *one property, operating under different modifications, is the universal cause of their activity.* That chemical changes are not the primary causes of the phænomena of galvanism may be fairly inferred: electricity is never exhibited in cases of mere chemical decomposition, nor can the electricity exhibited by the apposition of metallic surfaces be referable to chemical alteration.

These general facts and principles will be found to apply to many of the processes of chemistry, both in art and nature. They offer easy methods of separating acid and alkaline mat-

ter, in combination, in minerals, and of analysing animal and vegetable matters. Muscular fibre had thus potash, soda, ammonia, lime, and oxide of iron, evolved from it on the negative side, and the three common mineral acids, and the phosphoric acid on the positive side. From a laurel leaf, green-colouring matter with resin, alkali, and lime, appeared in the negative vessel, and a clear fluid with the smell of peach blossoms, and containing vegetable prussic acid, was found in the positive vessel. Phænomena also evince, that these powers of decomposition act on living vegetable and living animal matter: and as acids and alkalies may be thus separated from, so there is every reason for believing, that, by converse methods, they may be likewise introduced into the animal economy, or made to pass through the animal organs; and the same thing may be supposed of metallic oxides. These ideas, as Mr. Davy justly observes, ought to lead to some new and important investigations in medicine and physiology.

By pursuing these inquiries, electrical decomposition of neutral salts may be found applicable to the economical separations of acids and alkalies; the true elements of bodies may be discovered; alterations of electrical equilibrium in nature, and electric and meteoric appearances, may be easily explained, and tranquil and constant alterations, in which electricity is concerned, may be detected in the interior strata of our globe. Mr. Davy has indeed ascertained, that many mineral formations have been materially influenced, or even occasioned by these agencies of electricity, and conceives that the association of insoluble metallic and earthy compounds, containing acids, may be accounted for; and from successful experiments expects, that the electrical power of transference may serve to explain some of the principal and most mysterious facts in geology. The slow and silent operations of natural electricity,

in every part of the surface of the earth, he thinks, will probably be found more immediately and more importantly connected with the order and economy of nature, than in the case of its evident and powerful concentration in the atmosphere: investigations on this subject, he observes, can hardly fail to enlighten our philosophical systems of the earth; and may possibly place new powers within our reach.

To Mr. Davy we are indebted for the establishing of the following principles—that all bodies that chemically combined are naturally in opposite states; that if brought into the same state, they no longer enter into union; and that if the difference be exalted, they combine with more energy: that oxygen is, in its properties, opposed to all the other bodies in nature; that, wherever it exists in large proportions in compounds, it is always associated with one species of electrical power; and that it is naturally highly *negative*, and therefore combines with all bodies that are highly *positive;* but if made positive by artificial means, it separates from its compounds, and appears in its pure form.

The truly philosophic genius of Mr. Davy is manifested in the happy and appropriate application of the means of investigation, in his correct and comprehensive view of the phænomena presented to him, in the acuteness of discernment, and accuracy of reasoning, which enable him, not only to explain these phænomena, but also to mark those data, and to establish those principles which supply the power of farther extending his discoveries. By the most sedulous and energetic employment of these faculties, he has succeeded in the analysis of bodies which had never been yet decomposed, and in the discovery of the most important and interesting philosophical facts.

Potash, damp at the surface, was placed on an insulated surface, which was connected with the negative wire of the voltaic battery, and the wire from the positive side was placed on the upper surface of the alkali. The potash fused and effervesced, and small globules of a high metallic lustre, like those of quicksilver, appeared; some of which burnt with explosion and bright flame as soon as formed; whilst others were at first merely tarnished, but became finally covered with a white film. In this experiment, as in other decompositions, the combustible base was developed at the negative surface, and oxygen evolved at the positive surface. The white crust formed on the globules was found to be potash, and to have been produced by the oxygen of the atmosphere. The potash thus formed speedily absorbed water, which was again decomposed, the oxygen combining with the globule, and the hydrogen escaping; the process going on until the globule had assumed the form of a saturated solution of potash. When the globules were strongly heated in oxygen, a rapid combustion with a brilliant white flame was produced, and oxygen was absorbed, by which the globules were converted into a white and solid mass, which was found to be potash, and which exceeded in weight the combustible matter consumed. The separation of these principles seems to be the consequence of the combustible base of the fixed alkali being repelled, as other combustible substances, by positively electrified surfaces, and attracted by negatively electrified surfaces, the oxygen following the contrary order; or, the oxygen being naturally possessed of the negative energy and the bases of the positive, do not remain in contact when either of them is brought into an electrical state opposite to its natural one. In the synthesis, on the contrary, the natural energies or attractions come in equilibrium with each other; and when these are in a low state at common temperatures, a slow combination is effected;

but when they are exalted by heat, a rapid union is the result; and, as in other like cases, with the production of fire.

The inflammable base of potash acting almost on every body to which it was exposed, a difficulty arose as to confining it, until it was found, that it was defended, in a considerable degree, by being invested by a thin film of naphtha recently distilled. At 100° Fahr. the base was perfectly fluid, at 50° soft and malleable, and at about the freezing point it became harder and brittle, and of a crystallized texture. Its specific gravity at 62° Fahr. is to that of mercury as 10 to 223, and to that of water nearly as 6 to 10. It is a perfect conductor of electricity and of heat. It is the lightest fluid body known, and even in a solid state, at 40° Fahr. it swims in double distilled naphtha. To be converted into vapour it requires a temperature approaching that of red heat, when it is raised without alteration. Introduced into oxymuriatic acid gas it burns with a bright red light, and forms muriate of potash. Heated in hydrogen, it seems to dissolve in it, the gas, on passing into the air, exploding with alkaline fumes and bright light; but, by cooling, the base is either wholly or principally deposited. Brought into contact with water at common temperatures, it decomposes it with great violence, instantaneous explosion, and brilliant flame; a solution of pure potash being the result, and a white gradually extending ring of smoke arising, like that from the combustion of phosphuretted hydrogen. Placed upon ice it instantly burns with a bright flame, a hole being made in the ice containing solution of potash. In these experiments heat arises both from decomposition and combination, sufficiently intense to produce the inflammation, and a part of the globule being, in all probability, dissolved by the heated nascent hydrogen, this substance explodes spontaneously, and communicates the effect of combustion to any of the base

which may be yet uncombined. So strong is the attraction of this metal for oxygen, that it decomposes even the small quantities of water contained in alkohol and ether; forming with the oxygen potash, which, not being soluble in these fluids, is precipitated, and hydrogen is disengaged. It inflames and burns on the surface when thrown into solutions of mineral acids. It readily combines with the simple inflammable solids, and with the metals; with phosphorus and sulphur, it forms compounds similar to the metallic phosphurets and sulphurets. It amalgamates with mercury; but the mercury is freed from it as it unites with the oxygen of the air or of water. The fluid amalgam of this substance and mercury dissolved all the metals which were exposed to it; and in this state of union, mercury acts on iron and platina. It unites with gold, silver, or copper, when heated in close vessels; but when the compounds are thrown into water, the water is decomposed, potash is formed, and the metals are separated unaltered. Its action on oils and resins also shows its strong attraction for oxygen. It reduces metallic oxides, and decomposes glass. A globule placed on moistened paper tinged with turmeric, burns and moves rapidly on the paper, leaving behind it a deep reddish-brown trace.

Soda, when treated in the same manner as potash, yielded nearly analogous results: the inflammable base thus separated, became solid on cooling, and appeared to have the colour and lustre of silver. It was exceedingly malleable, much softer than any of the common metallic substances, and was so easily extensible as to be capable of being welded at common temperatures. Its specific gravity is to that of water nearly as 9 to 10, or more accurately as .9348 to 1. It has a much higher point of fusion than the basis of potash; becoming a perfect fluid at about 180°, and fuses readily under boiling naphtha.

The degree of heat at which it is volatile is not ascertained, it remaining fixed at the point of fusion of plate glass. The chemical phænomena produced by the basis of soda, are analogous to those produced by the basis of potash; but with such characteristic differences as might be well expected. From accurate experiments made to determine the proportions of the peculiar bases and oxygen in potash and soda, it appeared that potash consisted of about 6 parts basis and 1 of oxygen; and that soda consisted of 7 basis and 2 oxygen. The opacity, lustre, malleability, conducting powers as to heat and electricity, and their qualities of chemical combination, determining that these newly obtained substances should be called metals, Mr. Davy has named them POTASSIUM and SODIUM.

During the preceding course of inquiry, Mr. Davy suspected that oxygen might exist in the *volatile alkali*, as well as in the fixed alkalies; and that this was the case, he soon became satisfied by a series of most ingenious and well-adapted experiments; it proving to be a triple compound of nitrogen, hydrogen, and oxygen, in which the oxygen could not be estimated at less than 7 or 8 parts in 100. Oxygen then exists in and forms an element of all true alkalis; so that *the principle of acidity* in the French nomenclature, may be likewise called the *principle of alkalescence*. From analogy alone, Mr. Davy also thought it reasonable to expect that the *alkaline earths* were compounds of a similar nature to the fixed alkalis; and some experiments which he made at this period, went far, he thought, to prove that this must be the case, and that even lime, magnesia, glucina, alumina, and silex, might yield their elements to the methods of analysis by electrical attraction and repulsion.

Although potash and soda had never been considered as metallic in their nature, ideas had been entertained, from the earliest periods of chemistry, that the earths might be metallic substances. Whilst engaged in a series of experiments, which had detected a metallic substance in *barytes*, *lime*, *strontites*, and *magnesia*, Mr. Davy was informed by professor Benzelius, that, in conjunction with Dr. Pontin, he had succeeded in decomposing barytes and lime, by negatively electrifying mercury in contact with them; and that in this way he had obtained amalgams of the metals of these earths. These experiments were repeated by Mr. Davy with perfect success, and extending them to strontites and magnesia, he had analogous results. By combining the methods he had before employed with those of MM. Benzelius and Pontin, larger quantities of amalgams were obtained, and these, by a well-adapted apparatus and ingenious manipulations, had their mercury raised from them by distillation. The residuum of the amalgam of *barytes* appeared as a white metal of the colour of silver. It was fixed at all common temperatures, but became fluid at a heat below redness, and did not rise in vapour when heated to redness in a tube of plate glass, but acted violently upon the glass, producing a black mass, which seemed to contain barytes, and a fixed alkaline basis in the first degree of oxygenation. The metal from *strontites* sunk in sulphuric acid, and exhibited the same characters as that from barytes, except in producing strontites by oxygenation. The metal from *lime* could not be examined exposed to air, nor under naphtha. In one experiment in which the quicksilver was distilled to the greatest extent, the tube broke, and, on the air entering, the metal, which had the colour and lustre of silver, instantly took fire, and burnt with an intense white light into quick-lime. The metal from *magnesia* appeared as a solid, having the same whiteness and lustre as the other metals of the earths,

and quickly changed to a white powder, which was magnesia. Although the proportions of oxygen to the bases could not be ascertained, it was found, that whilst burning they absorbed oxygen, gained weight in the process, and were in their highly caustic or unslacked state. The metallic nature of the alkaline earths being thus established, the new substances were named by Mr. Davy, BARIUM, STRONTIUM, CALCIUM, and MAGNIUM.

Anxious to discover the real nature of the other earths, Mr. Davy made an immense number of experiments, with a hope of accomplishing the decomposition of *alumine*, *silex*, *zircon*, and *glucine*; and, from the general tenor of their results, he found great reason to conclude, that these earths, like the alkaline earths, are metallic oxides; the evidences of their decomposition and composition are not, however, of the same strict nature as those which belong to the fixed alkalis and alkaline earths.

Professor Benzelius and Dr. Pontin found that mercury, negatively electrified in the voltaic circuit, in contact with solution of *ammonia*, expanded to four or five times its former dimensions, and became a soft solid—AN AMALGAM OF THE BASIS OF AMMONIA AND MERCURY. An operation, in which hydrogen and nitrogen exhibited metallic properties; or in which a metallic substance was apparently composed from its elements, induced Mr. Davy to examine the circumstances connected with it minutely and extensively.

This amalgam at 70° or 80° is a soft solid, of the consistence of butter; at the freezing temperature it becomes firmer, and a crystallized mass. Its specific gravity is below 3, water being 1. In the air it acquires a crust of ammonia. In water it

produces a quantity of hydrogen, equal to about half its bulk, the water becoming a weak solution of ammonia. In muriatic acid gas, muriate of ammonia is formed, and a small quantity of hydrogen is disengaged. The quantity of basis of ammonia combined in 60 grains of quicksilver does not exceed $\frac{1}{200}$ part of a grain, and to supply oxygen, to this, scarcely $\frac{1}{1000}$ part of a grain of water is required. Professor Benzelius and Dr. Pontin regarded their experiment on ammonia as a strict proof of the idea Mr. Davy had formed of its being an oxide with a binary basis; and, in further proof of it, Mr. Davy found, that when the amalgam was confined in a given portion of air, the air enlarged in volume, and the pure quicksilver re-appeared: ammoniacal gas, equal to about one and a half of the volume of the amalgam being produced, and a quantity of oxygen, equal to one-seventh or one-eighth of the ammonia, disappearing. The more the properties of the amalgam obtained from ammonia, as Mr. Davy observes, are considered, the more extraordinary do they appear. Mercury, by combination with about $\frac{1}{12000}$ part of its weight of new matter, is rendered a solid, yet has its specific gravity diminished from 13.5 to less than 3; all its metallic characters, its colour, lustre, opacity, and conducting powers remaining unimpaired. But on what, Mr. Davy asks, do the metallic properties of AMMONIUM depend? Are hydrogen and nitrogen both metals in the aëriform state, at the usual temperatures of the atmosphere, bodies of the same character, as zinc and quicksilver would be in the heat of ignition? Or are these gases, in their common form, oxides, which become metallized by deoxidation? Or are the simple bodies not metallic in their own nature, but capable of composing a metal in their deoxygenated, and an alkali in their oxygenated state.

OXYGEN, he observes, is the only body which can be supposed to be elementary, attracted by the *positive surface* in the electric circuit: and all compound bodies, the nature of which is known, that are attracted by this surface, contain a considerable portion of it. HYDROGEN is the only matter attracted by the *negative surface*, which can be considered as acting the opposite part to oxygen. May not, then, the different inflammable bodies, supposed to be simple, contain this as a common element? Should this be proved, still the alkalis, the earths, and the metallic oxides, will belong to the same class of bodies; since, from platina to potassium, and perhaps to ammonium, there is a regular order of gradation as to their physical and chemical properties.

So rapidly have the valuable discoveries of this gentleman succeeded to each other, that, whilst this account was preparing for the press, his opening lecture at the Royal Institution announced that experiments which he had lately made, had given him reason to conclude that sulphur and phosphorus were triple compounds, containing oxygen, hydrogen, and peculiar bases; that plumbago was an alloy of the pure carbonaceous element and iron; that charcoal and the diamond were the same element; the former of these substances containing also a small portion of hydrogen, and the latter a very minute quantity of oxygen.

Employing the new metals, potassium and sodium, as instruments of analytic research, he has, by their agency, already decomposed the boracic and fluoric acids. He has also, by the same powerful agents, produced some extraordinary phænomena with sulphuretted hydrogen, carbonic acid, and carburetted hydrogen gases, these phænomena leading to the most unexpected and important conclusions. When heated in

contact with the gases just enumerated, these metals burn with the greatest brilliancy, although common combustible substances, when introduced into the same gases, in a state of inflammation, are instantly extinguished. During the experiment with the carbonic acid gas, the carbonaceous matter is represented as being precipitated in a most pleasing and beautiful manner.

Mr. Davy had, in the former part of the Bakerian lecture, referred the origin of volcanoes and subterraneous fires to the exposure of combustible metallic bases below the surface, to the oxygen of air and water: "From such an operation," he says, "intense heat must be generated, igneous explosions produced, the surrounding country convulsed, and the lava as a product of combustion poured forth upon the surface."

From recently discovered facts, Mr. Davy is also led to believe, that the renovation of the atmosphere depends rather upon electrical changes, than upon the agency of the vegetable kingdom.

It had been conceived from the experiments of the Swedish chemists, that the metals are probably compounds. This opinion is, however, not adopted by Mr. Davy; he concludes, indeed, from his experiments, that whenever hydrogen or nitrogen is condensed in a compound, free from oxygen, it forms a metallic alloy. He also conceives that the continual addition which is making to the number of the metals favours the idea, that ultimately there may be found only two species of matter on the globe—oxygenous and metallic, gifted with opposite energies, and capable of entering into an infinite variety of combinations.

Even whilst correcting this sheet, the editor learnt, that Mr. Davy had read another paper before the Royal Society, in which experiments are related, showing, that he had succeeded in the decomposition of nitrogen, which appears to be an oxide of hydrogen, containing a greater proportion of oxygen than even exists in water.

Thus are almost daily discoveries presented to us, every one of which are sufficient to give immortality to their author, and to set aside the most generally received opinions. Neither the phlogistic nor antiphlogistic theories of combustion can now explain several phænomena, which appear, however, to admit of easy explanation, on the principle of negative and positive energy. Chemical qualities are seen to coincide always with certain electrical state of bodies. Acids are uniformly negative, alkalies positive, and inflammable substances highly positive; and all are found to lose the peculiar properties and powers of combination, by a change of their electrical states. Chemical qualities are now shown to depend on electrical powers; and it is not impossible that matter of the same kind, possessed of different electrical powers, may exhibit different chemical forms.

Common muriatic acid, Mr. Davy has found to contain at least a third of its weight of water; and has not been able to procure it free from water in an uncombined state. He has, however, obtained combinations of muriatic acid with phosphorus, phosphoric, sulphuric acid, and with phosphorus, free from moisture; and these compounds, even when fluid, though constituted by matters supposed to be intensely acid, do not act on litmus paper, nor dissolve alkalis, and are non-conductors of electricity; but a very small quantity of water developes their energies, renders them conductors, and enables

them to act violently on litmus and alkaline bodies. With these compounds of muriatic acid, potassium detonates violently even at common temperatures; the muriatic acid being supposed to be decomposed in the experiment.

Thoughts on the Expediency of Disclosing the Processes of Manufactories; being the Substance of two Papers lately read before the Literary and Philosophical Society of Newcastle upon Tyne. *By* JOHN CLENNELL, *F. S. A. Edinburgh and Perth.*

PART I.

> And what invention's vigorous wing can bind?
> Ages to come may new inventions find.
>
> MRS. OPIE'S MAID OF CORINTH.

Among the many subjects that ought to have obtained the notice of literary men, there are some upon which, though the want of their cultivation is daily experienced, the attention of science has never yet been efficaciously fixed. My wish, then, is to introduce one of these to the attention of the public, in considering the expediency of a general and faithful display of the processes of manufactories, in such a manner that every chance may be obtained for effecting their highest improvement, with the least possible expence, by the inteference of the operations of science.

This subject appearing to me to be as yet almost unnoticed, I shall therefore take illustrations from every source that I

can; and as my most anxious wish is to effect all the good my power will allow, if I press into its service objects but seldom associated with it, objects, the study of which, in the opinion of many, are incompatible with the views of a manufacturer, I must shelter myself under that motive with those who would blame me for uniting them.

We cannot do better, I presume, than divide our subject into three parts: First, let us discover, if we can, the advantages, or the reverse, that secrecy has effected; secondly, the direct benefit attending disclosure; and thirdly, attempt to answer some objections urged by the advocates of mystery.

For the first division of our subject, we will take a view of the effects of concealment in those countries where it has chiefly prevailed; and as the principle of reserve, though in different directions, is still the same, whether it be in morals, in politics, or in the hands of the ancient priests, miscalled the teachers of mankind, we may be allowed to draw the same inferences from the same premises; and if we find, in the subjects we may produce, lamentable effects, from adopting the language of mystery and the practice of concealment, may it not justly be allowed, that both the one and the other ought to be discarded?

One advantage that may accrue from uniting in our survey the objects of more refined studies is, that they will relieve the dryness of a subject meant principally for the consideration of the manufacturer; we shall endeavour to mingle the pleasant with the useful; and although we may not insure success, yet it may cheer us in passing through the "palpable obscure," the view of the consequences of mysteries, and may help to enlighten the subject,

" As a glittering gem
" Upon an Ethiop's brow."

And, though a manufacturer, I presume, that those who cultivate classical studies, may not feel their favourite object debased, by its association with those of a more humble, it is true, but certainly of a not less useful nature. The first objects, as the eldest in which mystery is concerned, that claim our attention, are the hieroglyphics of Egypt: should these envelope, if I may so use the term, secrets of importance, who is it but laments the want of an index? If, like the volumes found in the ruins of Herculaneum and Pompeii, they contain nothing but what is now well known, may we not at least regret that this information was again to have the labour of discovery?

Of the richness of ancient architecture, what have we left but melancholy vestiges, " subverted shafts, broken entablatures, damaged capitals, mutilated friezes?" where are the plans from which these were erected? If time or war have nearly destroyed the buildings, African and Asiatic jealousy has concealed or annihilated the original designs.

In mechanics, as allied to architecture, by secrecy and mystery in the founders, the method is now lost by which those enormous masses of stone were piled upon each other, as in nearly all the druidical remains. The cement used by the ancients in building, is another instance, which, but for mystery, might not now have been that of unsatisfied inquiry; in vain have hitherto the builders of the present times attempted its discovery. The composition known to the ancients by the name of glesum, possessed properties partaking in some degree of the brilliancy of our glass, and the ductility of a metal. Petronius

Arbiter tells of a person who formed a cup of this substance, that could bear throwing down in a violent manner on the pavement, without any further injury than a bruise, which was beat out again by a hammer. The mode pursued by the ancients in dying the Tyrian purple, the old art of staining glass, the ancient method of working gems, in short, the preservation of all those arts whose extinction is so frequently deplored, would not only have saved an immensity of labour in prosecuting inquiries for their re-discovery, but that, together with the time and expence consumed in such researches, might have had other and more useful directions. In this view, it is much to be regretted, that no earlier intercourse had taken place between the European and Asiatic nations; or rather, that a desire to penetrate into their sciences had not sooner unfolded itself. What shall we think, if the illustrious discoveries of our European philosophers have been anticipated, by more than a thousand years, by the Brahmins of Indostan, as Mr. Maurice more than insinuates in the 7th vol. of his Indian Antiquities*?

And to what is so much destruction of usefulness, labour, expence, and time to be attributed, but the secrets of the compositions being in the possession of prejudiced men, whose fears for the spread of useful knowledge found its equal only in the ancient priesthood?

Formerly, from the jealousy of the coal-proprietors in Scotland, almost every colliery had its own vocabulary, and the workings were concealed with the greatest care. The consequence was, that much valuable fuel was lost, or locked up from the market. The history of banking too, in the same

* Dissertation on the Literature of the Hindoos, pages 570 to 826.

country, affords an instance of the impolicy of reserve and illiberal competition. Since this branch of business has been better understood, the parties concerned find their interest in the plan of honourable and mutual accommodation. Let then the present age, warned by its losses, secure to succeeding generations, by a contrary method, every possible advantage that its discoveries can produce.

History also laments her deficiencies, in the early accounts of nations. These, however, may be attributed to two causes: either there were no records made, or, if any facts were registered, they must have been surrounded with miracle, or recorded in hieroglyphics; in either case nothing remains but a lamentable proof of the insufficiency of such methods. If there really were none who would communicate, is it much better in the class that compose our manufacturers at present? We listen with pleasure to the recital of improvements in science, in morals, and in legislation; but those objects which are the support of thousands, those objects in which industry finds the widest scope, are scarcely yet participating in the otherwise general improvement!

From the lost arts, and the lost information of past times, the transition is easy to those whose secret is at present confined to one nation. "In the East Indies, the natives, by processes very simple, produce dyes, that European manufacturers have in vain endeavoured to imitate. The paints of China cannot be paralleled in Europe, for the sweetness and brilliancy of their colours, all of which there is good reason to believe are extracted from the vegetable kingdom only. The Indians of America, it is also well known, have many beautiful dyes, with which we are unacquainted; and in Africa the negroes, and the natives of the Brasils, have many plants that

furnish inestimable dyes, which are totally unknown to us. Here, then, opens up an immense field for improvement that cannot be exhausted. The natives of Scotland, and other northern parts of Europe, know how to extract beautiful dyes from many plants of no promising appearance. Among lichens and mosses, in particular, the variety of colours that may be obtained, is almost infinite; some of them inimitably beautiful*." The mode of making Russian leather, that also of forming shagreen, said to be manufactured by the Tartars, the various varnishes of the ingenious and industrious people of China, the composition of their porcelain, together with their modes of dyeing, painting, and enamelling it; we might also instance the kindred manufactory at Dresden, and many others, which, from the confinement they suffer, do not improve; besides that, in proportion to their concealment, so is the risk of their loss to the community.

Let us now turn to the second part of our subject, and give instances to prove the direct advantages attending disclosure. In the former part we looked to results from the experience of the selfishness and prejudices of past times. Objects for this divison will be best furnished by facts of the present day: these shall be our only testimonies and support; and, as the great weight of the question hinges here, it will be well to confine ourselves with a jealous eye to them. May we not assign, without fear of contradiction, not merely as one operating cause, but the sole cause of the improvements of agriculture, that it has courted science to contemplate its concerns, that, in almost every county of the united kingdom, well informed and liberal minded farmers are now found, who freely disclose their methods for the inspection or information of the

* Bee, by Dr. Anderson, vol. ix. p. 285.

public; and the consequence is, that not the public only, but themselves, are benefited by such liberality. One of these improvements it may be allowable to mention, without, in any degree, disparaging the rest. The threshing machine, and its various additions and simplifications, are they owing to mystery and concealment, or to knowledge and display? Medicine has, most fortunately for the human race, met with men studious of its improvement and promulgation, from Hippocrates and Galen, to the names of the present time. What a height of enviable cultivation has it obtained from the liberal spirit of communication that has existed so long! To mention its kindred science, chemistry, is alone sufficient to bring to our recollection the unremitted developements that have recently taken place; but this affords also a happy illustration of our first division, as well as the present one. What better example could be given of the inutility of mystery than a survey of the inane labours of the alchymist? and where can we, as it was before noticed, find a subject better adapted to display the great, the almost incalculable consequences of liberal communication, than in its advances? and by those advances a few manufactories have been also materially assisted. Astronomy too is another instance completely illustrative of the beneficial consequences of the principle we are attempting to establish. Whilst mystery and secrecy prevailed, with what was she conversant? An ally of magic, she assumed to discover good or bad fortune from the ascendancies of the benignant or the baneful planets. Connected with palmistry and physiognomy, she pretended to foretel, from the dispositions of the features of the face, and the lines of the hands, the happiness or misery of her deluded followers. Now, to bring the argument to our own times, as well as more directly to the object in view, viz. the advantages to be expected from having manufactories faithfully displayed, we

shall notice, in general terms, the improvements already introduced by chemistry into some of the arts. It is known that bleaching, dyeing, calico-printing, and a small portion of the rest are daily enjoying the benefits of her labours. Engines too, throughout the cotton, woollen, and linen manufactories, have been suggested, carried into effect, and are yet improving: an Arkwright has planned his models, and produced his machinery; Edmund Cartwright has added further improvements; and, from the successful conjunction of science with mechanics, by Bolton and Watt, we would almost be persuaded of the unlimited improvement of steam-engines, and their universal adoption wherever mechanical agency can be employed. Is it secrecy, or manly and unfettered communication, that has produced all this? Is it prejudice or science? If then mystery has once been so universal, and always, and in every instance, hostile to the true interests of man, why should we any longer continue it? If communication has been of such indisputable advantage in all the sciences, and in some manufactories, can it be believed, that towards those not yet benefited by its efforts, it is dangerous to allure its notice? If an enlightened reciprocal communication has done so much already, is it to be imagined that here it must stop, and not extend its usefulness to the whole circle of the objects of manufacturing industry? Error has frequently assumed the mask, and received the honours, of virtue; and the evil of not calling things by their right names is often severely felt. Such are the effects of an absolute prohibition to examine the processes of manufactories, which is exhibited so frequently to the public eye in "No admittance here without leave;" and this prohibition bears the name of prudential caution! Surely it is time to give it a title more expressive of its consequences in society; nay, so confined a view do we take of our own interest, that we yet meet, in common language, with "The mys-

teries of such a business," " The secrets of such a process." In our very printed indentures of apprenticeship, in uncouth and barbarous language, we have sentiments urging secrecy and reserve, congenial with their antiquated phraseology. It ought to be observed, however, here, that the openness for which I plead, does not, by any means, extend to secrets of profit or loss, strictly so called; and if the terms in indentures are always construed to mean no further, I should have no objections to them, other than that their language is almost obsolete; that they are vague and indefinite; and that their explanations rest too much on the will of the master. It is pretended, in another view, that the great motive for concealment is, lest any productive combination of machinery, or method of performing any operation, should be surreptitiously taken from the inventor. But why so? Lest another should reap the advantage of this fortunate process. But by its discovery, and submission to chemical and mechanical observation, some, or a great part of every one of the articles employed, might be dispensed with, by using only the most correct proportions of each, a knowledge of those proportions being obtained by chemical investigation; and not only so, but a great degree of simplification might be effected: thus capital, time, power, or room might be gained, or not misapplied; and would not these things, leading considerations in the mind of the manufacturer, be sufficient to compensate for others enjoying part of his advantages? It is also to be observed, that had scientific men acknowledged the principle of the danger of disclosure, it would have formed a rampart over which improvement could never have risen; it would have proved a *terminus* to every generous wish; a slaughter-house of ingenuity; under its death-devoting influence the sciences, whose present advances we contemplate with thankfulness, and whose increasing improvability gives the benevolent man increasing cause

for a bloodless triumph: those sciences would now, and for ever, present us with hieroglyphics, the energies of nature deified, the vagaries of the alchymist, the whimsical planetary distribution of beneficks, maleficks, triplicities, &c. of the astrologer, or the presumptuous and heart-rending auto-da-fé of the enthusiast: for the enthusiast, the astrologer, the Roman and Egyptian priests, all had their secret rites, and interior recesses, to which there was "no admission without leave;" and, in the latter instances, as they possessed the power, a gunpowder or electrical deity was elicited, to avenge the cause of his priest, insulted by the exercise of curiosity or free inquiry.

An objection is formed also, grounded on political motives, that the developement of the operations of manufactories is only placing objects in the sight of ministers, for the onus of taxation; on this, several observations offer themselves: in the first place, it is very obvious that those politicians who consider taxes as one great motive for exciting industry and ingenuity, will naturally arrange themselves in favour of our principle. It may also be suggested, that a partial, may often be more dangerous than an open and honourable, discovery. Erroneous statement or silence, may not only induce a false ground for taxation, but, from the mystery employed, afford presumptive proofs to the minister of finance that the business is lucrative, and therefore susceptible of a heavy tax. Nor is this, politically considered, the only evil; the manufacturer may lose more in confiscation, or even in time or vexatious interruptions, occasioned by licensed and ignorant inspectors, than he would have done in consequence of his discarding mystery. Again, may we not with confidence assert, that no barrier can eventually stop the progress of information? The links of the golden chain, said to be suspended from the throne of Jupiter, are not more closely united than is discovery to dis-

covery. The chemist and the engineer, like the pioneers of an army, or the first class of settlers in Pennsylvania, have already cleared away great part of the under-growth, the brambles and briars of secrecy, and the iron-oak of mystery will soon be removed so completely, that the place thereof shall know it no more. Even a year or two ago, some arts were enveloped in absolute darkness, which are now before the public. It may be said that these are chiefly those of other countries: attempts are nevertheless now and then making to enrich our periodical publications, with accounts of some of the English; every fresh communication is one step gained; and though it may be retarded frequently by error, yet there may be something of declaration and of fact in each of them, whilst their false statements may be detected and corrected by others in the same track.

It has been suggested, that science displays such innumerable and interesting objects to philosophers, that observations on the manufactories of the country are unattended to by them; whilst those who are particularly concerned in their improvement, are either so much engaged in the regular routine of attendance necessary in their respective concerns, or that not being in the habit of committing their thoughts to paper in the early part of their lives, the awkwardness attending a first attempt deters them. To these I would reply, that although the study of the arts of life may not yield so sublime an enjoyment, as contemplating the grand and awful scenes that astronomy, or chemistry, or any other of the sciences can disclose; yet, that they are worthy a small portion of the attention of the friend of wisdom and of his species, is, I hope, not to be doubted. The engagements of manufacturers to their business do not so entirely engross their time, but some small part of it might be dedicated to a collection of facts in that business, to which,

they say, they so unremittingly attend; and if want of custom alone prevents their properly arranging them, which is allowing too much if they do indeed apply so intensely, that very business would suggest its own regular course of observations, which, when attended to, particularly for the purpose of either giving or receiving information, their former inattention to pursuits allied to literature would seldom prove a barrier to their attempts; but the very wish to communicate would secure in most cases a correspondent action; it would naturally create a habit of attention, or would influence the manufacturer to seek assistance where he conceived himself defective. But the great question occurs here, who will disclose? To this I reply, gentlemen who have declined business in each, or any branch, or may be about doing so, if principles of liberality are not powerful enough to induce those to do so who are already in it, with the intention of continuing it. But in the multiplicity of manufacturers, we can scarcely suppose, that there will not be found one at least, if not more, of each branch, who are both able and willing to display their respective processes; and not only so, but to add to their communication the improvements which they may themselves have discovered. Even of this more inaccessible species of information, instances are not wanting of individual disclosure from the most disinterested motives, and that by men, eminent equally for the strength and reach of their understandings as for the liberality and patriotism of their views.

The late Mr. Wedgewood had a meeting every fortnight at his house, of all the master potters in the neighbourhood, where his discoveries were freely described, and their improvements, if they had made any, were as liberally communicated.

About six years ago, "a friendly association of the iron-masters of the counties of York and Derby was instituted, for the purpose of freely discussing the several subjects connected with their important manufactory, and of mutually communicating their various improvements to any individual member, in order to the general benefit. This idea was proposed by Mr. Dawson, of Royd's Hall, the able director of the Low-Moor iron-works*."

To these can now be added a third instance of equal liberality, but with this difference, that whereas the two former received nothing of immediate personal advantage, but what was part, as it were, of a general stock, the following had a slight recompence presented him, though probably the gift was made more to show a sense of their gratitude and of his patriotic sentiments and exertions, than offered as a reward. The following is copied from the Chronicle, a weekly paper, published at Newcastle, by Mrs. Hodgson.

"On the 19th of February, 1807, died William Simpson, Esq. at Lasswade. He was the first who introduced in England, into the paper-manufactory, the improved method of bleaching, by means of the muriatic acid, and he generously communicated the result of his long and expensive experiments to the trade at large, which they acknowledged by making him a present of a handsome piece of plate."

In what a noble point of view do these men, and such as these, appear, particularly when contrasted with those who have carelessly or wilfully allowed their discoveries to perish with them! The one party we view as the benefactors of their spe-

* See Eighth Year's Report of the Literary and Philosophical Society of Newcastle upon Tyne.

cies, arrayed with the genuine feelings of man, and, like the luminary of day, dispensing blessings around them; the other, like the darkness and unfruitfulness of night, reaping where they did not sow, blasting where they can the generous labours of others, and depriving themselves of the exalted pleasure of doing good, forgetful that to bestow benefits, with the same willingness as to receive them, are equally imperious duties.

But supposing further, that these discoveries are made, and in the possession of a few who are ready to publish them: daring, it may be said, would those few be, who would attempt the plan or direct the arrangement; more so, than the person who first ventured to sea on a float. It were indeed necessary for them, neither to fear boisterous power, the blasting frosts of prejudice, nor the sorrowful lamentations of those disappointed men who wish to entail delusion and ignorance on their species, nor the mischief of the combinations of journeymen, than which there is no greater tyrant of the manufacturer. What degree of toil do they fear, who can with stedfast eyes behold, with an intention to destroy, the monsters Combination and Monopoly, more dreadful to the public, than are to mariners the hideous Acroceraunian rocks!

" Illi robur et æs triplex
Circa pectus erat, qui fragilem truci
Commisit pelago ratem
Primus, nec timuit præcipitem Africum
Decertantem Aquilonibus,
Nec tristes Hyadas, nec rabiem Noti,
Quo non arbiter Adriæ
Major tollere, seu ponere vult freta.
Quem mortis timuit gradum,
Qui fixis oculis monstra natantia,

Qui vidit mare turgidum, et
Infames scopulos Acroceraunia?"
HORACE, Book I. Ode III.

It is granted that manufactories, looking at them in the whole, appear, to an unpractised eye, like the stars of heaven; and like them too, the indistinctness of our present field of view confounds us almost at our first approaches: but being separated, like them, into divisions or constellations, we can examine them at leisure, obtain arrangement, and consequently we can examine them with effect. A division of manufactories may be accomplished in something like the following manner, chemical, mechanical, and those which partake of the two. Under the first may be classed the productions of salt, alum, copperas, Prussian blue, &c.; under the second, the cotton, worsted, linen, and silk manufactories may be arranged; and under the third, the smelting of metals, which requires a combination of chemical and mechanical knowledge.

There are two reasons which have been urged, why we have so seldom found manufactories displayed by their owners; the infrequency, and the supposed impropriety, of the union of literature and business: but these have been so ably replied to in the first volume of the Transactions of the Manchester Literary and Philosophical Society, by Mr. Henry, and by Dr. Barnes in the second volume of the same work, that it might be considered presumption in me offering any additional remarks. I shall therefore conclude this part in the words of Dr. Gregory, on the Usefulness of Literature, in the fourth volume of the above work: "I have attempted to arrange my ideas on a subject which I should wish to see taken up by some more able hand, but which appeared to me of too much importance to be utterly neglected."

To be continued.

Circular Letter of the Philadelphia Linnean Society.

Philadelphia, August 16th, 1809.

SIR,

It is in conformity with the directions of the Philadelphia Linnean Society, and in their behalf, that we have now the honour of addressing you. The principal object in establishing this society was the promotion of natural history, and particularly that of our own country. In the whole circle of science, there is nothing more pleasing, more interesting, or more beneficial, than the study of nature; and of all the countries in which this study can be pursued, there is certainly none that presents greater advantages than America.

Without doubt, the only practical method of obtaining a history of the natural objects of our country, is to concentrate the observations made in its various parts. We, therefore, beg of you, sir, as a lover of science, that you would communicate to us the result of your observations on natural history, particularly that of your own neighbourhood.

It is not, by any means, our wish to direct or to limit your inquiries. Your remarks on any of the branches of natural history we will always receive with pleasure. One suggestion, however, we take the liberty of making: our society is now forming a cabinet of plants and minerals, the usefulness of which must, in a great measure, depend on its extent and perfection. In order to advance this undertaking, we beg you to communicate specimens of the plants and minerals of your vicinity, accompanied by notes, designating their scientific and vulgar names when they can be obtained, their locality, and,

in regard to plants, their time of flowering. To these necessary notes you will add such other observations concerning them, as you may deem interesting or useful.

Should you, sir, in compliance with these wishes, favour the society by a communication, you will please to direct it to either of the subscribers, and may be assured of a prompt acknowledgment.

We have the honour to be, sir,

Your humble servants,

SAMUEL BETTON, JUN.
SAMUEL COLHOUN,
SAMUEL HAZARD,
Corresponding Committee for the Philadelphia Linnean Society.

Method of Fining Madeira Wine.

"Much of the most excellent of our wine is, when new, darker than the darkest-coloured port or claret; this colour gradually becomes paler, as the wine gets older, till at last it comes to a deep, rich, golden hue. Nothing but age can completely produce this change, though it may be a little accelerated by racking and fining down; but if milk or blood, or any strong fining is used, though it will reduce the colour, and render it much paler, yet the liquor will be impoverished; and, by the attempt to anticipate the appearance of age, the wine may be rendered nearly as sharp and vapid as if originally bad. The only fining which should be ever used, is the white of fresh hen's eggs: the quantity of from four to six is as much as is necessary for a pipe. Their whites are to be beaten up into a

lather, so as to destroy their adhesive quality; then to be well mixed with a gallon of wine, drawn from the cask, and this mixture is then to be put into the wine, which must be be well stirred for a quarter of an hour. In eight or ten days, if the weather is fine, and in twelve or fifteen, if it is variable, the operation of fining will be complete, and the wine should be racked or drawn off. This ought to be done with care, not suffering any of the lees or dregs to come away. These lees or dregs may be afterwards put in a smaller cask, and, when settled, the clear liquor drawn off; and this operation may be repeated till little except mere sediment is left."

[*Extract from a memoir written by an associate of one of the most respectable houses in Madeira.*

Empiricism.

That an Empiric is generally afraid of his own nostrum, is confirmed by many humorous anecdotes that might be brought forward. On one occasion, we are told, a dealer of this description was obliged to send for a physician, through inadvertence in the use of his own specific. The physician, on feeling his pulse, and going through the usual routine of investigation that attends a visit to a patient, expressed his surprize to find his patient so much alarmed at such an apparently trifling indisposition. "Ah! doctor," replied the empiric, "not so very trifling as you suppose; for, alas! to tell you the truth, I have, in a mistake, swallowed some of my own medicine."

The truth of this we may confirm by stating, that within our own knowledge, instead of requiring the assistance of Dr. Bro-

dum, or taking his far-famed medicines, his family generally put themselves under the care of the regular profession for ailments which it is pretended his specifics can infallibly cure. So much for the principles of those concerned in this shameful traffic, the various branches of which are every day expanding, and assuming new shades of imposition.

It would seem that, even in the days of the celebrated author of Hudibras, the public were equally imposed on by the deceptions of quackery, as at the present day; and we have no doubt it will be gratifying to our readers, to have the picture of an empiric of that period delineated by so able a pen.

"The empiric," says this author, "is a medicine-monger, probationer of receipts, and doctor epidemic: he is perpetually putting his medicines upon their trial, and very often finds them guilty of manslaughter, but still they have some trick or other to come off, and avoid burning by the hand of the hangman. He points his trials of skill, and challenges death at so many weapons, that though he is sure to be foiled at every one, he cares not: for if he gets money, he is sure to get off. For it is but posting up diseases for poltroons in all the public places of town, and daring them to meet him again, and his credit stands as fair with the rabble as ever it did. He makes nothing of the pox, and the running of the reins, but will undertake to cure them, and tie one hand behind him, with so much ease and safety, that his patients may surfeit and be drunk as often as they please, and follow their business, that is, whores and him, without any inconvenience to their health and occasions; and he cures with so much secrecy, that they shall never know how it came about. He professes, no cure no pay, as well he may; for, if nature does the work, he is paid for it; if not, he neither wins nor loses; and, like a cun-

ning rook, lays his bet so artfully, that, let the chance be what it will, he either wins or saves. He cheats the rich for their money, and the poor for charity, and if either succeeds, both are pleased: and he passes for a very just and conscientious man; for, as those that pay nothing ought at least to speak well of their entertainment, their testimony makes way for those that are able to pay for both. He finds he has no reputation among those who know him, and fears he is never like to have; and therefore posts up his bills to see if he can thrive better among those that know nothing of him. He keeps his post continually, and will undertake to maintain it against all the plagues of Egypt. He sets up his trade on a pillar, or the corner of a street: these are his warehouses, where all he has is to be seen, and a great deal more, for he that looks further finds nothing at all."

[*Lond. Med. & Surg. Spect.*

On the Practice of Sophisticating Drugs.

Gentlemen—I am of opinion, that some good may arise from exposing the villanous system of sophisticating drugs, which in this great town is carried on to a pitch truly alarming; I am not sure that some harm may not arise from it, as it may have a tendency to render still weaker that confidence in the profession at large, which *this* and many other causes have, I am sorry to say, for a length of time, been gradually undermining. I, not long ago, by chance, stumbled upon a *pharmacopœia officinalis* of one of those pests of society. I shall, at present, only extract two articles, which will serve to give you an idea of the mischievous consequences which such nefarious conduct may necessarily lead to.

1*st. Unguentum Hydrargyri fortius.*

Take of ivory black, one ounce; hog's lard, one pound. Mix.

2*d. Pulvis Ipecacohannæ.*

Take of emetic tartar, one ounce; linseed powder, one pound. Mix.

While the wretched sufferer under the most horrid disease, with which (for good reasons no doubt) Providence has been pleased to afflict mankind, is amusing himself by rubbing in the former, as a specific, the innocent parent is, perhaps, administering the latter to her more innocent offspring; the convulsions and deadly effects of which are too frequently mistaken for the natural consequences of the disease for which it had been administered.

I remain, gentlemen,

YOUR CONSTANT READER.

[*Lond. Med. & Surg. Spect.*

Medical News.

Dr. Williamson, of Baltimore, is engaged in translating, and has nearly ready for the press, "The Elements of Hygiène, or the Influence of Physical and Moral Things upon Man, and on the Means of Preserving Health. By Etienne Tourtelle, professor at the Special School of Medicine of Strasbourg, member of several national and foreign academies, and an associate of the institution of health and salubrity for the prefecture of the sitting guard at Nîmes." In this treatise,

the author has not been content with taking man from his birth, of following him through the different periods of life, of considering him under latitudes the most opposite; of remarking the influence which climate, government, religion, regimen, &c. have, not only upon his organization, but also upon his mental faculties.

There are now in the press, in this city, an edition of the Works of Dr. Sydenham; also of Dr. Cleghorn's Treatise upon the Diseases of Minorca, with notes, intended to render them both more useful to American readers, by Benjamin Rush, M. D. professor of the institutes and practice of medicine, &c. in the University of Pennsylvania.

A third edition of the doctor's Medical Inquiries and Observations is likewise in the press, revised and enlarged by the author. It is expected all these works will appear some time in November next.

Professorship of Chemistry in the University of Pennsylvania.

At a meeting of the trustees of the University of Pennsylvania, on Monday, July 10, 1809, John Redman Coxe, M. D. was appointed professor of chemistry in that university, in place of Dr. James Woodhouse, lately deceased.